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METHODOLOGY FOR HYDROLOGIC PREDICTIONS

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METHODOLOGY FOR HYDROLOGIC PREDICTIONS

1. Twelve representative watersheds were chosen on the basis of their geographic locations and vegetative, hydrologic, soil, and climatic characteristics.

2. Each watershed was located on a 7.5 minute topographic map.

3. Vegetative, hydrologic soil group, and allotment overlays were made for each watershed.

4. Each hydrologic response unit (i.e., vegetative type within a given soil type within a given pasture) was planimetered to determine the percent of the total area in the watershed. (A planimeter is an instrument that measures the area of a plane figure as a mechanically coupled pointer traverses the figure's perimeter.)

5. Each hydrologic unit was assigned a cover density using data collected during Phase I of the Bureau of Land Management's (BLM's) Watershed Conservation and Development System. Percent vegetative cover was added to the percent litter and half of the large rock plus small rock to get the cover density used in the Soil Conservation Service (SCS)

model for predicting runoff.

6. Infiltration rates were measured within each hydrologic soil group with a double ring infiltrometer.

7. A curve number was assigned to each unit using the equations in table A-5 where possible and table A-6 when the soil type within the unit did not coincide with the equations in table A-5.

8. A weighted curve number was then calculated for each watershed.

9. The rainfall upon which runoff calculations were based was arrived at using the following procedure developed by Fogel and Hekman (1977).

To obtain relationships between elevation and selected precipitation variables, several climatological stations with daily precipitation records were chosen from the Grand Junction Resource Area with the help of the BLM hydrologist. The selected stations and their elevations are as follows: Grand Junction, 4855'; Colorado National Monument 5280'; Rifle, 5400'; Cedaredge, 6180'; and Bonham Reservoir, 9835'. Since the Colorado National Monument and Rifle stations are located at relatively similar elevations, subsequent analyses used average values of these two stations. The two precipitation variables required for simulating a time series of events are precipitation depth and interarrival

TABLE A-5
CURVE NUMBERS AS A FUNCTION OF COVER DENSITY (CD)
AND INFILTRATION RATE f (INCHES PER HOUR)

Vegetative Cover	Limits of application		Equation
	CD(%) a/	f(in/hr) b/	CN =
Juniper-Grass		none	92.4-4.8f-(0.25+0.08f)CD
Sage-Grass		none	96.0-10.5f-(0.49-0.035f)CD
Herbaceous		none	92.5-5.0f-(0.12-0.072f)CD
Oak-Aspen		none	83.4-4.25f-(0.39+0.055f)CD
Ponderosa Pine	>10%, <80%		90.0-8.0f-(0.02+0.13f)CD
Pasture or Rangeland	none	<2.13	92.06-4.26f-(0.11-0.08f)CD
	<50	>2.13	92.06-4.26f+(0.154-0.204f)CD
	>50	>2.13	113.91-14.55f-0.28CD
Annual Grass	none	<2.13	92.5-4.47f-(0.12+0.065f)CD
	<50	>2.13	95.37-5.82f+(0.019-131f)CD
	>50	>2.13	118.53-16.72f-(0.461-0.095f)CD
Forests	none	<1.13	89.0-8.24f-(0.20+0.02f)CD
	none	>1.13	102.41-14.55f-(0.20+0.02f)CD
Roads	CD=0	<2.13	92.0 - 4.24f
	CD=0	>2.13	98.45 - 7.27f

Source: Gifford, Hawkins, and Williams (1975).
a/ CD = cover density in percent.
b/ f = infiltration rate in inches per hour.

TABLE A-6

COEFFICIENTS FOR RUNOFF CURVE NUMBER (Y) AS A FUNCTION OF PERCENT COVER (X), AND Y + a - bX FOR VARIOUS VEGETATIVE TYPES AND SOIL GROUPS

Vegetative Type	Soil Group	a	b	Notes
Juniper-Grass	C	88	0.32	1/
	B	82	0.42	1/
Sage-Grass	C	86.5	0.46	1/
	B	73.5	0.415	1/
Herbaceous	D	95	0.115	1/
	C	90	0.19	1/
	B	84	0.25	1/
Oak-Aspen	C	79	0.44	1/
	B	74	0.51	1/
Desert Brush	D	93	0.06	2/ 3/
	C	80	0.06	2/ 3/
	B	84	0.06	2/ 3/
Ponderosa Pine	C	83	0.14	2/ 4/
	B	73	0.31	2/ 4/
Pasture or Rangeland	A	77	0.56	3/
	A	63	0.28	6/
	B	83	0.28	
	C	89	0.18	
	D	91	0.13	5/
Annual Grass	A	75	0.44	3/
	A	60	0.13	6/
	B	83	0.26	
	C	89	0.08	
	D	91	0.13	7/
Forests (precipitation = 25 inches)	A	50.5	0.286	
	B	71.5	0.229	
	C	81.5	0.229	
	D	87	0.21	7/
Roads	A	73	0.00	
	B	83	0.00	
	C	88.5	0.00	
	D	90.5	0.00	7/
Bare Rock	(N.A.)	96	0.00	8/
Water Surfaces	(N.A.)	100	0.00	

Note: All above curve numbers for AMC II and I_a = 0.2S, cover without rocks. 1/ From Enderlin and Markowitz (1962). 2/ From Simanton, Renard, and Sutter (1973). 3/ For X<50 percent. 4/ For 10 percent X<80 percent. Nonlinear relationship to Y = 92 and Y = 83, respectively at X = 0. 5/ From NEH-4 (in table form); reduced and converted to above coefficients. 6/ For X>50 percent. Note similarity between annual grass and rangeland coefficients except for Soil Group "A." 7/ From unpublished tables from USFS personnel (personal communication). 8/ Assumes (Initial Abstraction) = 0.08 inch.

time.

A 6-month season, May through October, was chosen to represent the time of the year when changes in the hydrologic effects caused by changing the grazing management program would be most noticeable. In that time period storm durations were assumed to be less than one day so that each day in which rainfall was recorded was assumed to be a separate event. While this was not necessarily correct at all times, inspection of the National Weather Service hourly climatological data for Grand Junction showed that in only a relatively few times did effective precipitation carry over from one day to the next.

With a storm thus defined, data for the two distributions were extracted from National Weather Service records. At least 15 years of data were used in all cases. Gamma probability distributions were selected as being able to best fit the data. For the interarrival time distribution, a shifted gamma distribution was used to obtain a better fit. The shift was one day since the probability of a one day interarrival time was a constant for all elevations, 0.41. The mean and the variance for each of the two distributions were determined from the data (see table A-7).

The next step was to obtain a relationship between elevation and both the mean and variance for the two

TABLE A-7
STATISTICAL PARAMETERS OF PRECIPITATION VARIABLES
AT SELECTED ELEVATIONS

Station elevation,	Precipitation depth, inches		Interarrival time, days	
feet	Mean	Variance	Mean	Variance
4855	0.127	0.029	7.77	59.00
5340	.153	.040	6.61	52.55
6180	.166	.043	6.53	47.97
9830	.315	.153	5.22	32.74

distributions. Regression analyses were made and in all four cases the model that gave the best fit was of the form

$$Y = b0 + b1\ X + b2\ X^2 \qquad (1)$$

in which X is elevation in thousands of feet and Y is either the mean or variance. In all instances, the correlation coefficient was greater than 0.95. Values for the coefficients in the above equation are shown in table A-8 while figure A-9 illustrates the relation between elevation and the means of the two distributions. Thus, for any elevation between 4,800 and 10,000 feet in the Grand Junction Resource Area, estimates can be made for the mean and variance of the two precipitation variables, precipitation depth and interarrival time. In turn, these estimates describe a particular gamma distribution

$$f(X) = X\ \frac{(X_X\ ^{k-1} e^{-X_X}}{(k-1)!} \qquad (2)$$

where X = mean/variance and

k = $(\text{mean})^2/\text{variance}$

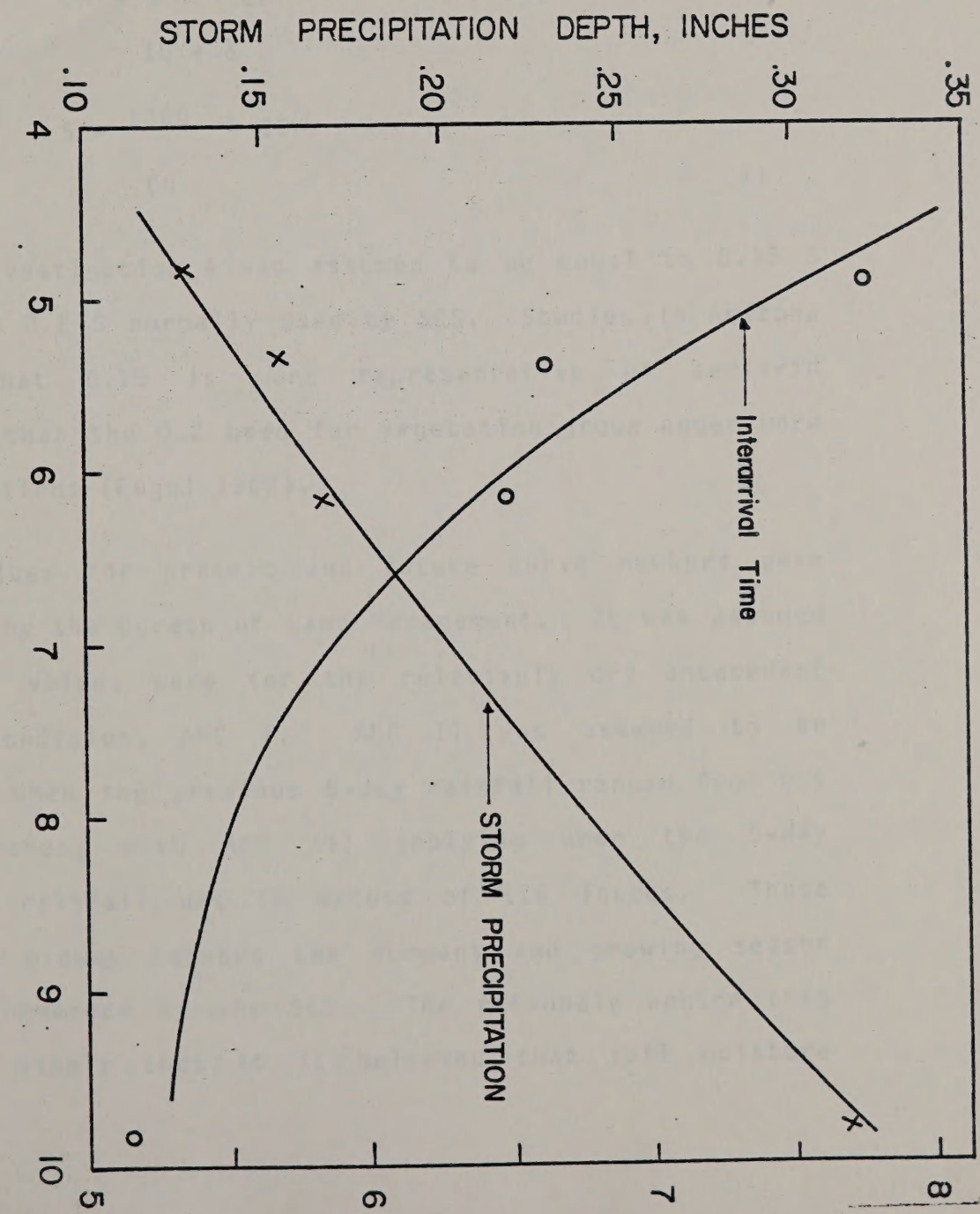
10. The SCS method was used for estimating runoff (Soil Conservation Service, 1972). Storm runoff resulting from rainfall is expressed as

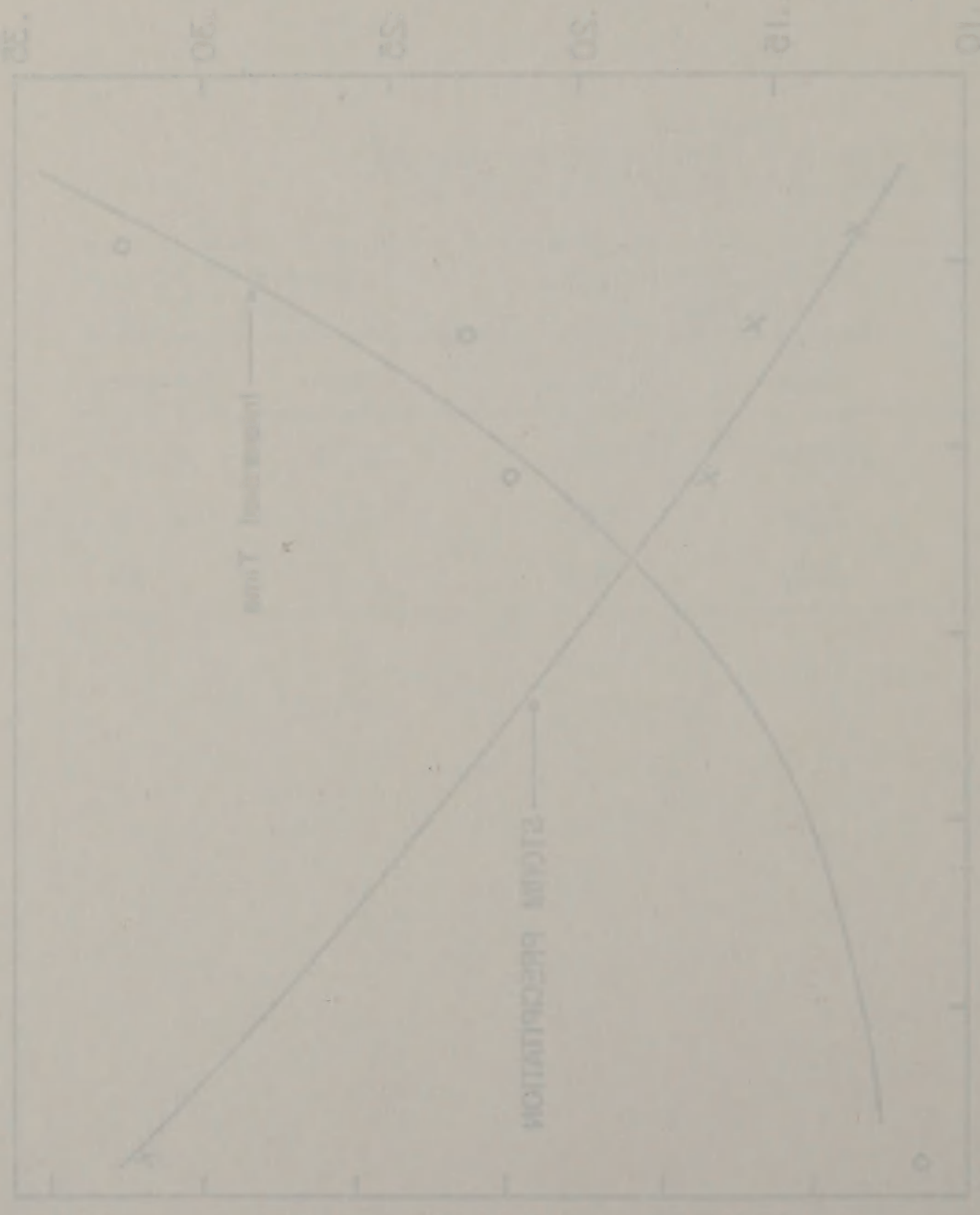
$$V = \frac{(R - A)^2}{(R - A) + S} \qquad (3)$$

TABLE A-8
VALUES FOR REGRESSION COEFFICIENTS IN EQUATIONS
RELATING ELEVATION TO STATISTICAL PARAMETERS

Coefficient	Precipitation depth, inches		Interarrival time, days	
	Mean	Variance	Mean	Variance
b_0	0.0534	0.0996	15.43	123.07
b_1	.0057	-.0329	-2.21	-17.44
b_2	.0022	.0039	.12	.84

Figure A-9
Effect of Elevation on means of storm precip. and interarrival time





where V is runoff, R is storm precipitation as determined in step 9, S is the potential maximum retention, and A is the initial abstraction. All terms are expressed as depths, inches in this case. A runoff curve number (CN) is related to S by

$$CN = \frac{1000}{10 + S} \quad \text{or}$$

$$S = \frac{1000}{CN} - 10 \qquad (4)$$

For this investigation A was assumed to be equal to 0.15 S rather than 0.2 S normally used by SCS. Studies in Arizona indicate that 0.15 is more representative of semiarid conditions than the 0.2 used for vegetation grown under more humid conditions (Fogel 1969).

Values for present and future curve numbers were determined by the Bureau of Land Management. It was assumed that these values were for the relatively dry antecedent moisture condition, AMC I. AMC II was assumed to be applicable when the previous 5-day rainfall ranged from 0.9 to 1.6 inches, with AMC III applying when the 5-day antecedent rainfall was in excess of 1.6 inches. These values are midway between the dormant and growing season values recommended by the SCS. The rationale behind this choice is simply that it is believed that soil moisture

losses from the 5,000-to 8,000 - foot BLM watersheds may be less than at lower elevations. This would also be true for less dense vegetation, which is the existing situation, in comparison to the SCS values developed under more humid conditions. Thus, it was reasoned that for the BLM watersheds, lower antecedent precipitation should have a similar affect on runoff as the higher values used by the SCS. Given the curve number for condition I, CN1, the curve numbers for conditions II and III, CN_2 and CN3, are obtained from table A-9 taken directly from the SCS handbook.

11. The peak discharge was estimated using the SCS equation as follows:

$$Q = \frac{484\ AV}{0.5\ D + 0.6\ T_c} \qquad (5)$$

where Q is the peak discharge in cfs,

A is watershed area in square miles,

V is runoff volume in inches,

D is duration of excess rainfall in hours, and

T_c is the time of concentration in hours.

D was assumed to be a constant equal to one hour. Inspection of the National Weather Service hourly precipitation data for Grand Junction indicated that a substantial part of what was deemed to be runoff - producing storms occurred in a one-or two-hour period. This, then,

CURVE NUMBERS (CN) AND CONSTANTS FOR THE CASE $I_a = 0.2S$

1	2	3	4	5	1	2	3	4	5
CN for condition II	CN for conditions I	CN for conditions III	S values* (inches)	Curve* starts where P = (inches)	CN for condition II	CN for conditions I	CN for conditions III	S values* (inches)	Curve* starts where P = (inches)
100	100	100	0	0	60	40	78	6.67	1.33
99	97	100	.101	.02	59	39	77	6.95	1.39
98	94	99	.204	.04	58	38	76	7.24	1.45
97	91	99	.309	.06	57	37	75	7.54	1.51
96	89	99	.417	.08	56	36	75	7.86	1.57
95	87	98	.526	.11	55	35	74	8.18	1.64
94	85	98	.638	.13	54	34	73	8.52	1.70
93	83	98	.753	.15	53	33	72	8.87	1.77
92	81	97	.870	.17	52	32	71	9.23	1.85
91	80	97	.989	.20	51	31	70	9.61	1.92
90	78	96	1.11	.22	50	31	70	10.0	2.00
89	76	96	1.24	.25	49	30	69	10.4	2.08
88	75	95	1.36	.27	48	29	68	10.8	2.16
87	73	95	1.49	.30	47	28	67	11.3	2.26
86	72	94	1.63	.33	46	27	66	11.7	2.34
85	70	94	1.76	.35	45	26	65	12.2	2.44
84	68	93	1.90	.38	44	25	64	12.7	2.54
83	67	93	2.05	.41	43	25	63	13.2	2.64
82	66	92	2.20	.44	42	24	62	13.8	2.76
31	64	92	2.34	.47	41	23	61	14.4	2.88
80	63	91	2.50	.50	40	22	60	15.0	3.00
79	62	91	2.66	.53	39	21	59	15.6	3.12
78	60	90	2.82	.56	38	21	58	16.3	3.26
77	59	89	2.99	.60	37	20	57	17.0	3.40
76	58	89	3.16	.63	36	19	56	17.8	3.56
75	57	88	3.33	.67	35	18	55	18.6	3.72
74	55	88	3.51	.70	34	18	54	19.4	3.88
73	54	87	3.70	.74	33	17	53	20.3	4.06
72	53	86	3.89	.78	32	16	52	21.2	4.24
71	52	86	4.08	.82	31	16	51	22.2	4.44
70	51	85	4.28	.86	30	15	50	23.3	4.66
69	50	84	4.49	.90					
68	48	84	4.70	.94	25	12	43	30.0	6.00
67	47	83	4.92	.98	20	9	37	40.0	8.00
66	46	82	5.15	1.03	15	6	30	56.7	11.34
65	45	82	5.38	1.08	10	4	22	90.0	18.00
64	44	81	5.62	1.12	5	2	13	190.0	38.00
63	43	80	5.87	1.17	0	0	0	infinity	infinity
62	42	79	6.13	1.23					
61	41	78	6.39	1.28					

*For CN in column 1.

CURVE NUMBERS (CN) AND CONSTANTS FOR THE CASE $I_a = 0.25$

was assumed to be the time when runoff occurred, a period of relatively high intensity. Although fairly large rainfall amounts may be recorded for a 2-hour period, the time of maximum intensity would be somewhat less, and hence, the 1-hour duration of excess rainfall was assumed.

There are several methods for estimating the time of concentration, T_c, of a watershed. In this study, the upland method as presented by the SCS (Soil Conservation Service 1972) was used. The method estimates flow velocities for various channel slopes and overland flow or channel conditions (see figure A-10). In most instances, the channel was assumed to be in the form of an upland gully.

In estimating storm sediment yield from a particular subarea within the watershed, an estimate of peak discharge as well as runoff volume is needed. Equation 5 was used, but (T_c) for a sub-area was estimated as a fraction of the total time based on the ratio of subarea to total area.

12. A modified form of the Universal Soil Loss Equation (Wischmeier and Smith 1965) was used to relate runoff variables and watershed parameters to storm sediment yield. Proposed by Williams and Berndt (1972), the equation is

$$Z = 95\ (LS)\ C\ K\ P\ (V\ \ Q)^{0.56} \qquad (6)$$

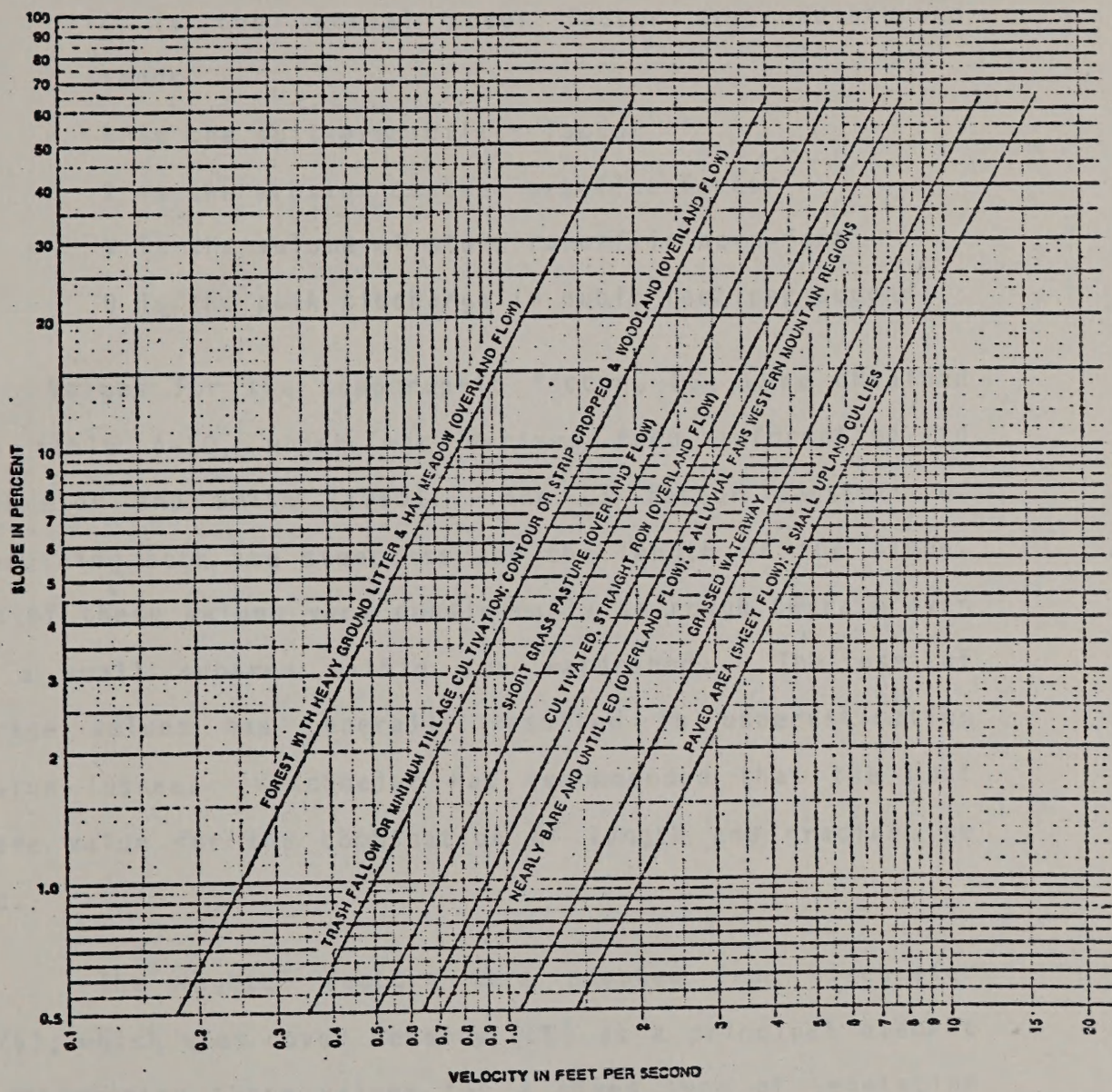
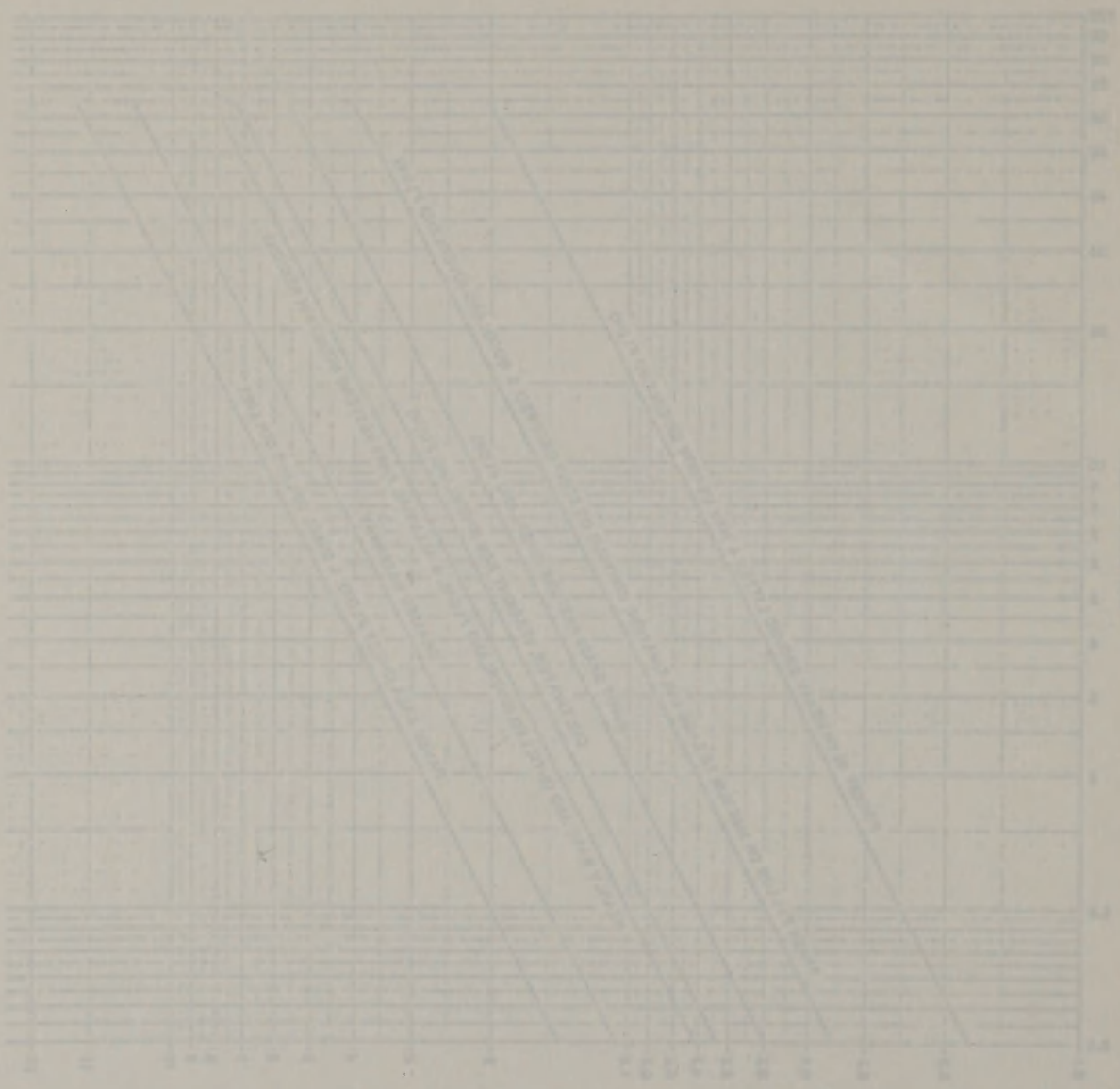


FIGURE A-10
VELOCITIES FOR UPLAND METHOD OF ESTIMATING T_c



where Z is the storm sediment yield in tons

LS is the slope length and gradient factor

C is the vegetal cover factor for undisturbed lands

K is the soil-erodibility factor

P is the erosion control practice factor

V is the volume of storm runoff in acre-feet

Q is the peak discharge in cubic feet per second.

Values for the topographic factor, LS, were obtained from table A-10, which was derived from information in Wischmeier and Smith (1965). The LS factor consists of determining both the steepness and the length of the slope. Both of these values vary considerably in rough terrain even for a small subarea within the watershed. The use of average values has generally resulted in underestimating erosion losses. Wischmeier has recommended that the most severe value for the combination of length and gradient be used.

The vegetal factors were adapted from Wischmeier (1975), which uses cover density (CD) as a principal element in determining these values for a given type of vegetation (see table A-11). Thus, the C-factor changes from the present to the future situation, the result of estimated changes in cover density.

The soil-erodibility factor K was difficult to quantify

TABLE A-10
SLOPE-EFFECT (TOPOGRAPHIC FACTOR, L

Percent Slope	Slope Length in Feet													
	10	20	40	60	80	100	110	120	130	140	150	160	180	200
0.2	0.04	0.05	0.06	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.10	0.10
0.3	0.04	0.05	0.07	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.11
0.4	0.05	0.06	0.07	0.08	0.09	0.09	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11
0.5	0.05	0.06	0.08	0.08	0.09	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.12	0.12
1.0	0.06	0.08	0.10	0.11	0.12	0.13	0.13	0.14	0.14	0.14	0.15	0.15	0.15	0.16
2.0	0.10	0.12	0.15	0.17	0.19	0.20	0.21	0.21	0.22	0.22	0.23	0.23	0.24	0.25
3.0	0.14	0.18	0.22	0.25	0.27	0.29	0.30	0.30	0.31	0.32	0.32	0.33	0.34	0.35
4.0	0.16	0.21	0.28	0.33	0.37	0.40	0.42	0.43	0.44	0.46	0.47	0.48	0.51	0.53
5.0	0.17	0.24	0.34	0.41	0.48	0.54	0.56	0.59	0.61	0.63	0.66	0.68	0.72	0.76
6.0	0.21	0.30	0.43	0.52	0.60	0.67	0.71	0.74	0.77	0.80	0.82	0.85	0.90	0.95
8.0	0.31	0.44	0.63	0.77	0.89	0.99	1.04	1.09	1.13	1.17	1.21	1.25	1.33	1.40
10.0	0.43	0.61	0.87	1.06	1.23	1.37	1.44	1.50	1.56	1.62	1.68	1.73	1.84	1.94
12.0	0.57	0.81	1.14	1.40	1.61	1.80	1.89	1.98	2.06	2.14	2.21	2.28	2.42	2.55
14.0	0.73	1.03	1.45	1.78	2.05	2.29	2.41	2.51	2.62	2.72	2.81	2.90	3.08	3.25
16.0	0.90	1.27	1.80	2.20	2.54	2.84	2.98	3.11	3.24	3.36	3.48	3.59	3.81	4.01
18.0	1.09	1.54	2.17	2.66	3.07	3.43	3.60	3.76	3.92	4.06	4.21	4.34	4.61	4.86
20.0	1.29	1.82	2.58	3.16	3.65	4.08	4.28	4.47	4.65	4.83	5.00	5.16	5.47	5.77
25.0	1.86	2.63	3.73	4.56	5.27	5.89	6.18	6.45	6.72	6.97	7.22	7.45	7.90	8.33
30.0	2.52	3.56	5.03	6.16	7.11	7.95	8.34	8.71	9.07	9.41	9.74	10.06	10.67	11.25
40.0	4.00	5.66	8.00	9.80	11.32	12.65	13.27	13.86	14.43	14.97	15.50	16.01	16.98	17.90
50.0	5.64	7.97	11.27	13.81	15.94	17.82	18.69	19.53	20.32	21.09	21.83	22.55	23.91	25.21
60.0	7.32	10.35	14.64	17.93	20.71	23.15	24.28	25.36	26.40	27.39	28.36	29.29	31.06	32.74

Percent Slope	Slope Length in Feet													
	300	400	500	600	700	800	900	1000	1100	1200	1300	1500	1700	2000
0.2	0.11	0.12	0.13	0.14	0.15	0.15	0.16	0.16	0.17	0.17	0.18	0.19	0.19	0.20
0.3	0.12	0.13	0.14	0.15	0.16	0.16	0.17	0.18	0.18	0.18	0.19	0.20	0.21	0.22
0.4	0.13	0.14	0.15	0.16	0.17	0.17	0.18	0.19	0.19	0.20	0.20	0.21	0.22	0.23
0.5	0.14	0.15	0.16	0.17	0.18	0.18	0.19	0.20	0.20	0.21	0.21	0.22	0.23	0.24
1.0	0.18	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.27	0.28	0.29	0.30	0.32
2.0	0.28	0.31	0.33	0.34	0.36	0.38	0.39	0.40	0.41	0.42	0.43	0.45	0.47	0.49
3.0	0.40	0.44	0.47	0.49	0.52	0.54	0.56	0.57	0.59	0.61	0.62	0.65	0.67	0.71
4.0	0.62	0.70	0.76	0.82	0.87	0.92	0.96	1.01	1.04	1.08	1.12	1.18	1.24	1.33
5.0	0.93	1.07	1.20	1.31	1.42	1.52	1.61	1.69	1.78	1.86	1.93	2.07	2.21	2.40
6.0	1.17	1.35	1.50	1.65	1.78	1.90	2.02	2.13	2.23	2.33	2.43	2.61	2.77	3.01
8.0	1.72	1.98	2.22	2.43	2.62	2.81	2.98	3.14	3.29	3.44	3.58	3.84	4.09	4.44
10.0	2.37	2.74	3.06	3.36	3.62	3.87	4.11	4.33	4.54	4.74	4.94	5.30	5.65	6.13
12.0	3.13	3.61	4.04	4.42	4.77	5.10	5.41	5.71	5.99	6.25	6.51	6.99	7.44	8.07
14.0	3.98	4.59	5.13	5.62	6.07	6.49	6.88	7.26	7.61	7.95	8.27	8.89	9.46	10.26
16.0	4.92	5.68	6.35	6.95	7.51	8.03	8.52	8.98	9.42	9.83	10.24	11.00	11.71	12.70
18.0	5.95	6.87	7.68	8.41	9.09	9.71	10.30	10.86	11.39	11.90	12.38	13.30	14.16	15.36
20.0	7.07	8.16	9.12	9.99	10.79	11.54	12.24	12.90	13.53	14.13	14.71	15.80	16.82	18.24
25.0	10.20	11.78	13.17	14.43	15.59	16.66	17.67	18.63	19.54	20.41	21.24	22.82	24.29	26.35
30.0	13.78	15.91	17.79	19.48	21.04	22.50	23.86	25.15	26.38	27.55	28.68	30.81	32.80	35.57

TABLE A-11
"C" VALUES FOR GRASSLAND, RANGELAND, WOODLAND AND IDLE LAND

Vegetal Canopy	Percent Ground Cover					
	0	20	40	60	80	95-100
Grass	.26	.16	.11	.09	.03	.01
Brush	.34	.18	.13	.09	.04	.01
Mountain Shrub	.28	.17	.12	.08	.04	.003
Pinon - Juniper	.36	.20	.13	.06	.04	.003
Forest	.25	.14	.09	.06	.03	.003
Waste	.45	.24	.15	.09	.04	.01

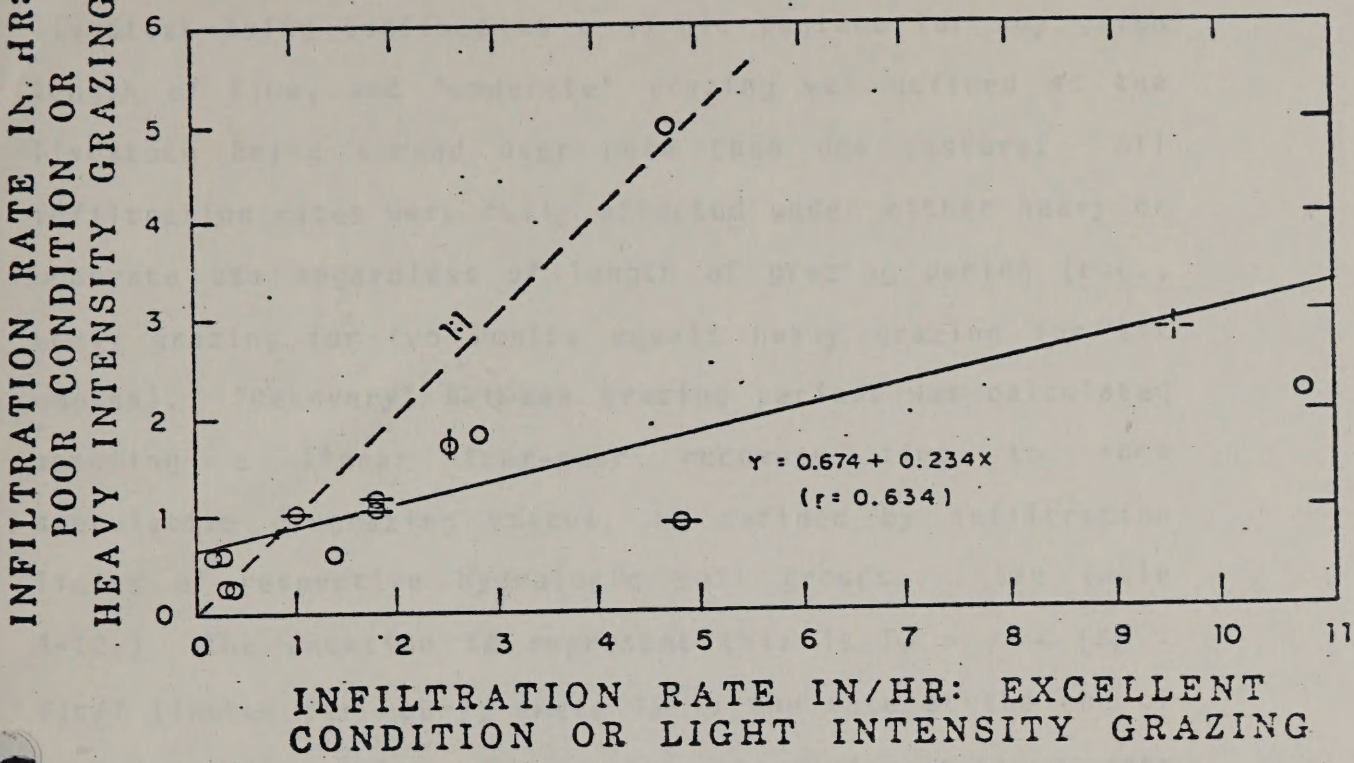
SOURCE: Adapted from Wischmeier, W.H., Estimating the Soil Loss Equation's Cover and Management Factor for Undisturbed Areas. Agricultural Research Service, USDA, ARS - S - 40, 1975, pp. 118-124.

with the type of information that was available. Fortunately, this value does not change from the present to the future. It was decided to relate K to the hydrologic soil group classification used by the SCS. Based on SCS national and regional technical notes, estimated K-values that were used in this study were 0.20, and 0.35 and 0.30 for hydrologic soil groups B, C, and D respectively. Weighted means were calculated for each soil type.

It should be mentioned that while values for the three parameters LS, C, and K may depend on individual interpretation, in this particular case BLM is interested in differences rather than absolute values. In addition, the Universal Soil Loss equation will only predict surface erosion and not channel erosion. Since most of the erosion taking place in the ES area is channel erosion, only a small fraction of the total erosion is being quantified.

13. Grazing within each pasture was plotted for the twenty years required to achieve full effects of the allotment management plans (AMPs). Periods of spring-summer and fall-winter grazing were recorded and the length of rest between grazing was also noted.

14. The infiltration rate at the end of the twenty-year period was calculated for each unit by applying the regression equation presented in figure A-11. "Heavy" grazing, under a rotation scheme, was defined as all



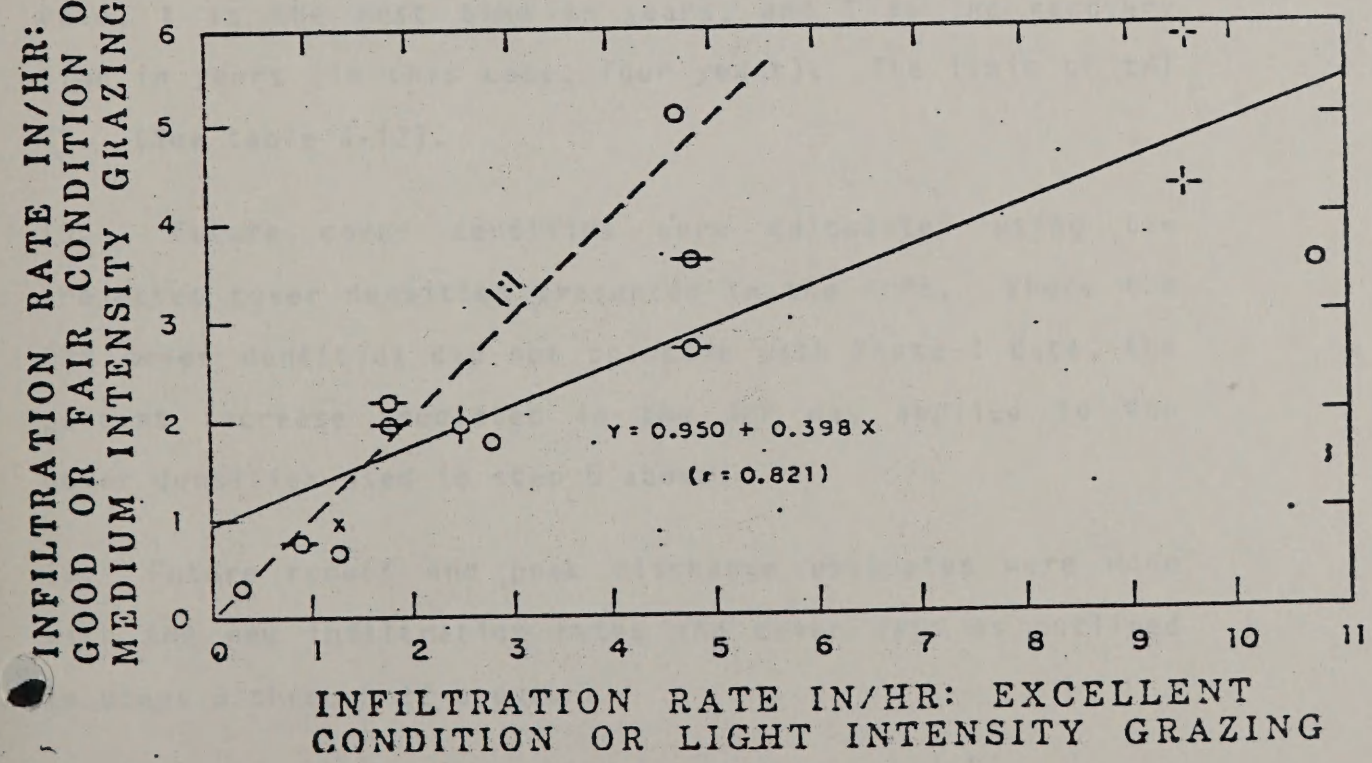
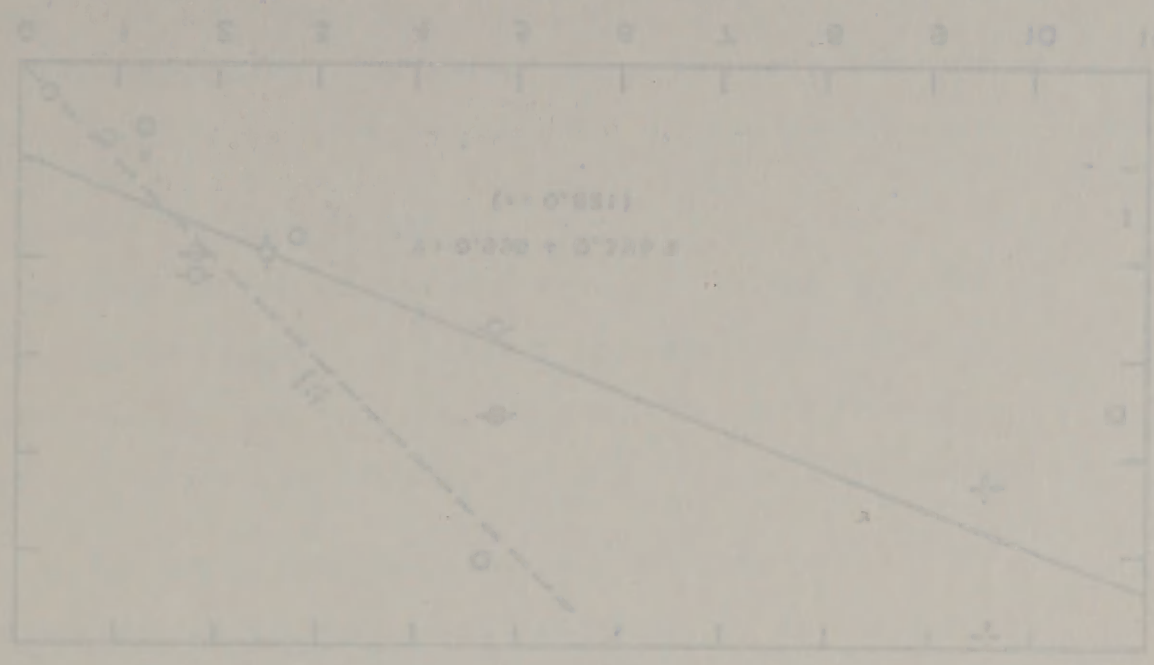
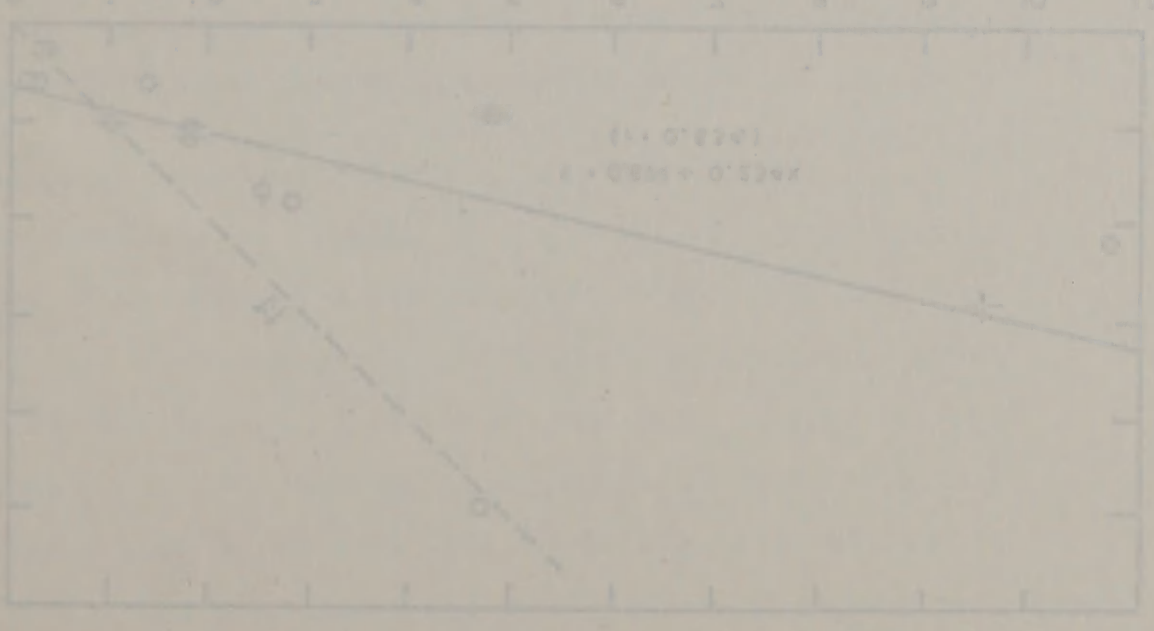


FIGURE A-11
CHANGES IN INFILTRATION RATES WHEN CHANGING FROM LIGHT TO MODERATE GRAZING INTENSITIES (Source: Gifford et al. 1975).





livestock being confined to a single pasture for any given length of time, and "moderate" grazing was defined as the livestock being spread over more than one pasture. All infiltration rates were fully affected under either heavy or moderate use regardless of length of grazing period (e.g., heavy grazing for two months equals heavy grazing for six months). "Recovery" between grazing periods was calculated assuming a linear four-year recovery time to some speculative pregrazing status, as defined by infiltration limits of respective hydrologic soil groups. (See table A-12.) The equation to represent this is $F_r = F + (f_o - f)t/T$ (inches per hour), where f_r is the rate at the end of the recovery period, f_o is the pregrazing optimum rate defined by the hydrologic soil group, f is the beginning rate, t is the rest time in years, and T is the recovery time in years (in this case, four years). The limit of $t/T < 1$. (See table A-12).

15. Future cover densities were calculated using the projected cover densities presented in the AMPs. Where the AMP cover densities did not coincide with Phase I data, the percent increase predicted in the AMP was applied to the cover densities used in step 5 above.

16. Future runoff and peak discharge estimates were made with the new infiltration rates and cover data as outlined in steps 5 through 12 above.

TABLE A-12
SAMPLE OUTPUT FOR REST ROTATION HYDROLOGIC IMPACT MODEL

From	To	Time (yr)	Activity	Infiltration Rate Begin	End	
1 Jan	16 Jan	1.46	Rest	1.80	1.92	a/
16 Jun	15 Aug	0.17	Heavy Cattle	1.92	1.12	
15 Aug	15 Oct	0.17	Rest	1.12	1.17	
15 Oct	25 Jan	0.28	Moderate Sheep	1.17	1.17	
25 Jan	16 Aug	0.56	Rest	1.17	1.30	
16 Aug	15 Oct	0.17	Moderate Cattle			
15 Oct	1 Jan	0.20	Moderate Sheep	1.30	1.30	b/

a/ Hydrologic Soil Group "B"; present infiltration rate under moderate grazing 1.80 inches per hour = 0.950 + 0.398 (2.13). Infiltration rate for ungrazed "B" is 2.13 inches per hour. End infiltration rate (1.92 inches per hour) = (2.13-1.80) 1.46/4 + 1.80.
b/ Tandem cattle and sheep counts as a single grazing, in this case at "moderate" level.